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(71) Applicant(s)
Design Technology & Innovation Ltd

(Incorporated in the United Kingdom)

Chalvington House, Chalvington, Hailsham,
EAST SUSSEX, BN27 3TQ, United Kingdom

(72) Inventor(s)
Mark Christopher Tonkin

(74) Agent and/or Address for Service
Hepworth Lawrence Bryer & Bizley
Merlin House, Falconry Court, Bakers Lane, EPPING,
Essex, CM16 5DQ, United Kingdom

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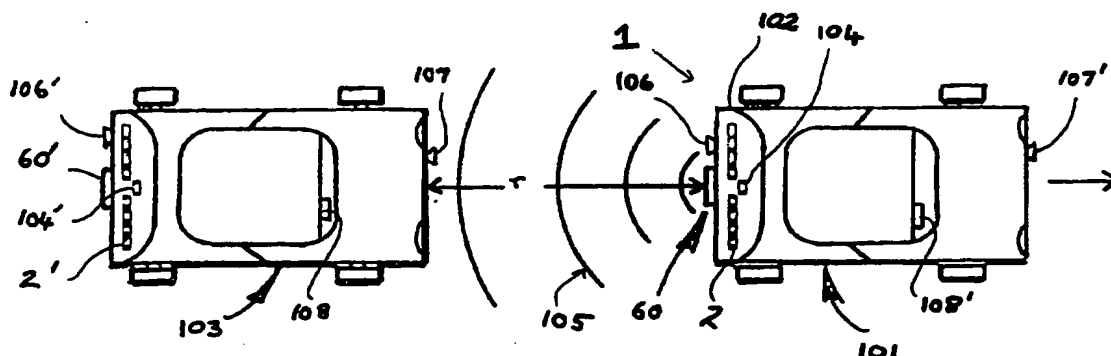
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(54) Indicating state of motion of a vehicle; vehicle ranging device

(57) The state of motion of a vehicle 101 may be indicated to a following vehicle 103 by an array of lamps 2 on the vehicle 101, and/or by an audible and/or visual indicator 108 mounted on the dashboard of vehicle 103 and radio controlled 106, 107 from vehicle 101. The number of lamps of array 2 which are illuminated increases as the level of deceleration increase above successively higher ones of a first set of thresholds, and decreases as the deceleration rate decreases below successive ones of a second threshold set (Figs.3,5). The lamps may also be of progressively increasing size. Threshold levels of the second set are lower than corresponding ones of the first set, and the threshold levels may depend on vehicle speed, either increasing (Fig.6) or decreasing with speed. Deceleration may be determined from vehicle speed or by an accelerometer. The deceleration indication may be inhibited unless a brake pedal switch has also been operated, or may function independently of the brake pedal switch.

When the vehicle speed drops below a first threshold indicative of a stationary or near stationary vehicle, the lamps of array 2 are illuminated in a pattern cyclically moving outwardly from a central region to create an animated vehicle stationary indication (Fig.4 A to E). This indication is turned off when the vehicle speed increases above a second speed threshold, which may be greater than, equal to, or less than the first speed threshold. The animated indication switches to a static vehicle stationary indication, with only an outer pair of lamps energised (Fig.4F), if a proximity sensor 60 detects that the following vehicle 103 has closed to within a first range (R1, Fig.8) of the vehicle 101, a switch back to the animated indication occurring if vehicle 103 subsequently falls outside a second range (R2; R2 > R1).

Fig1



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Fig 2

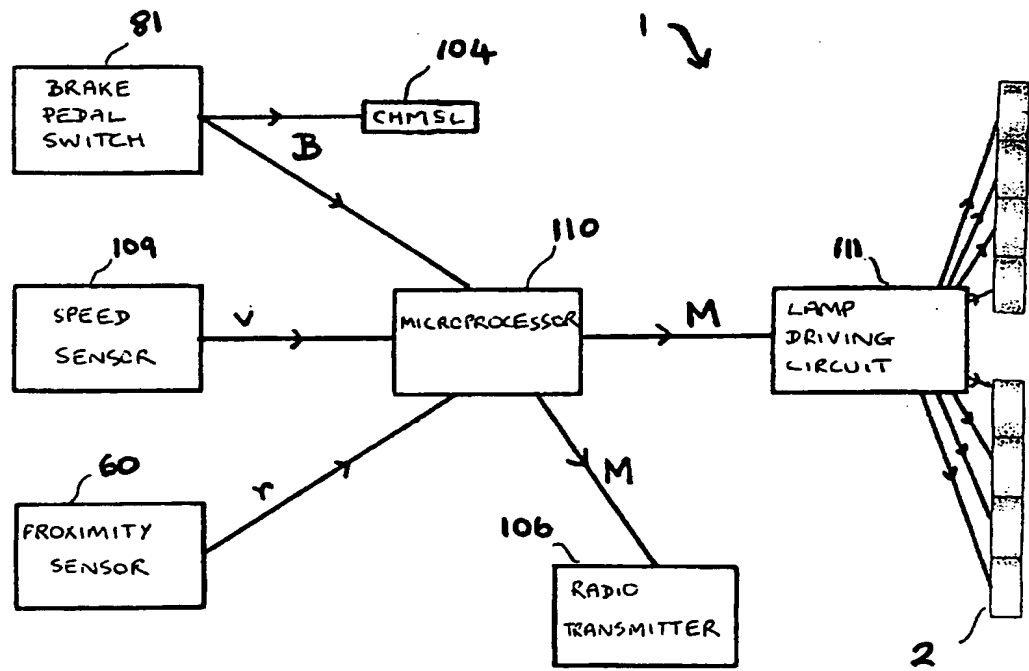


Fig 3

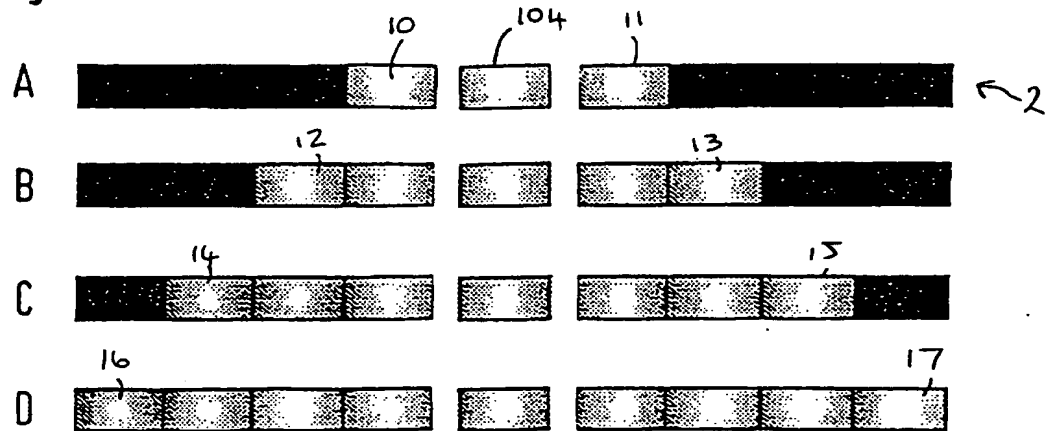


Fig 10

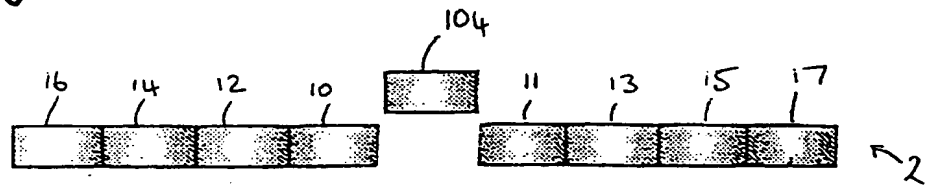


Fig 11

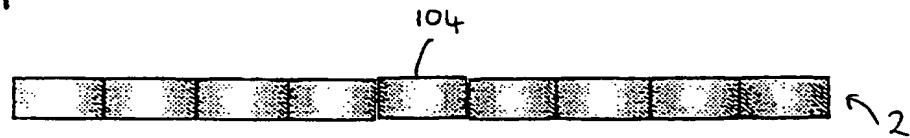
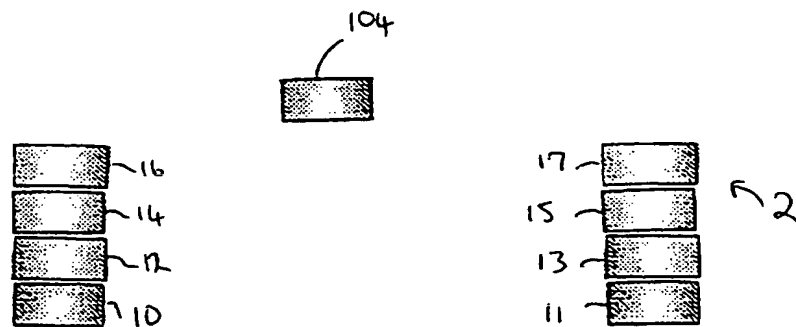


Fig 12



4/a

Fig 4

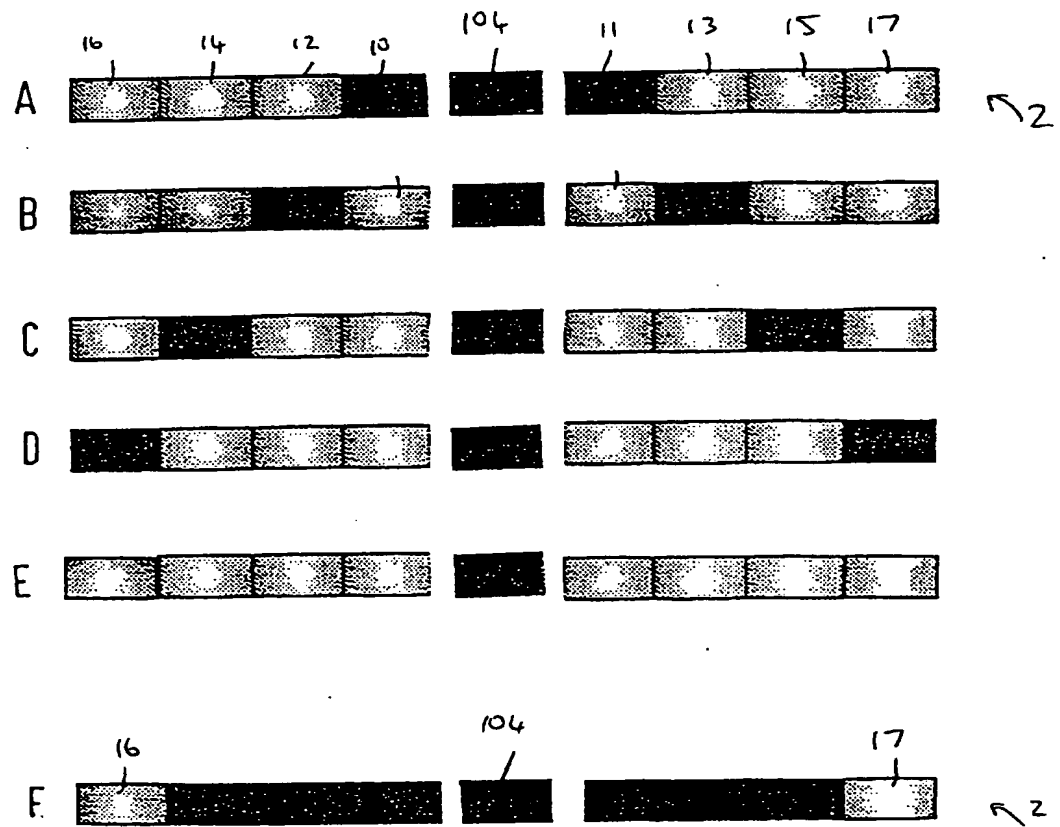


Fig 5

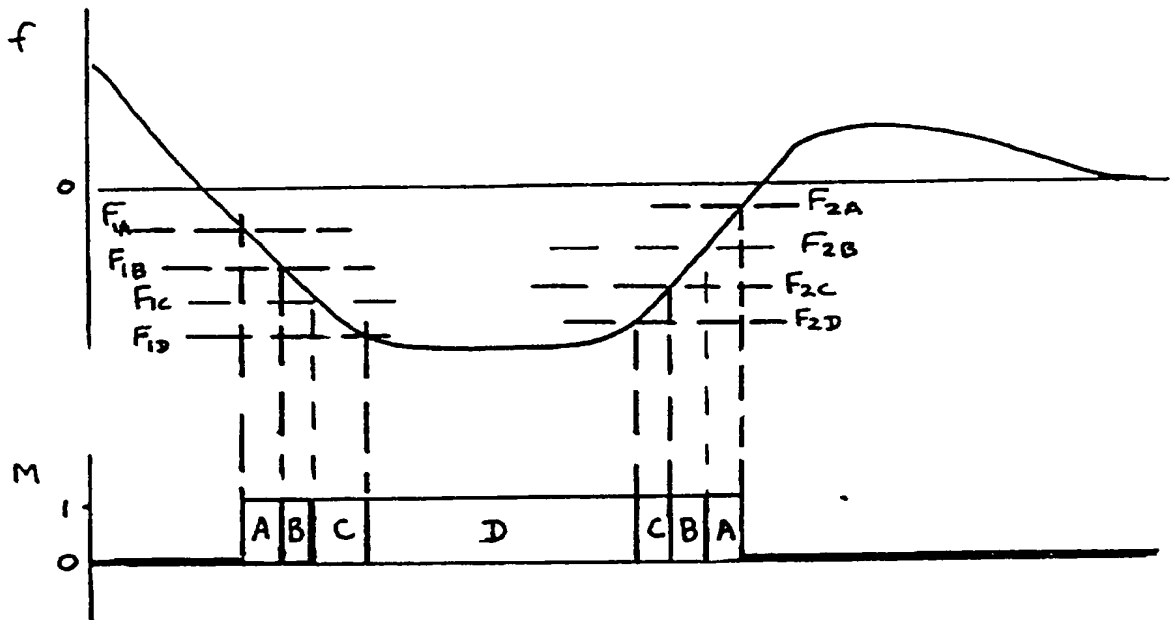
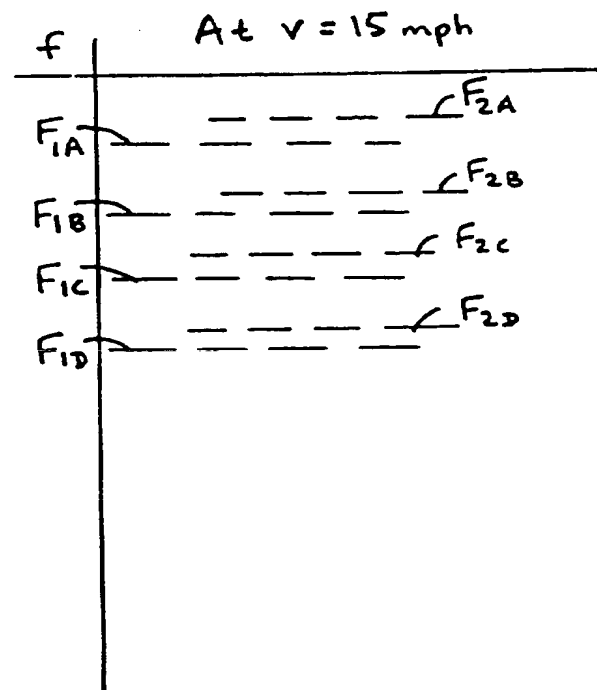
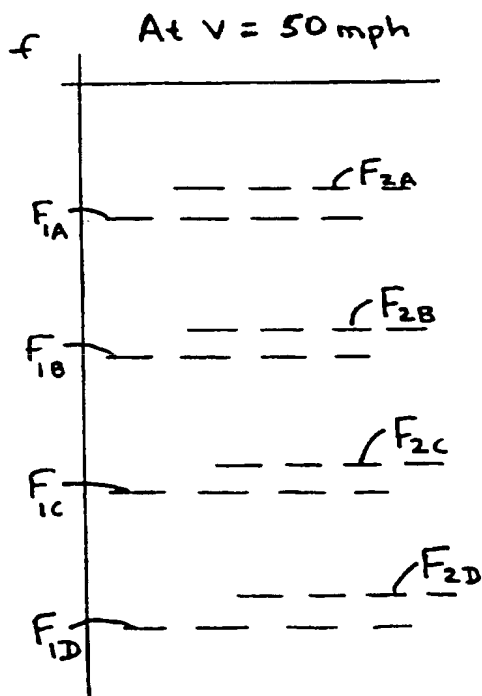
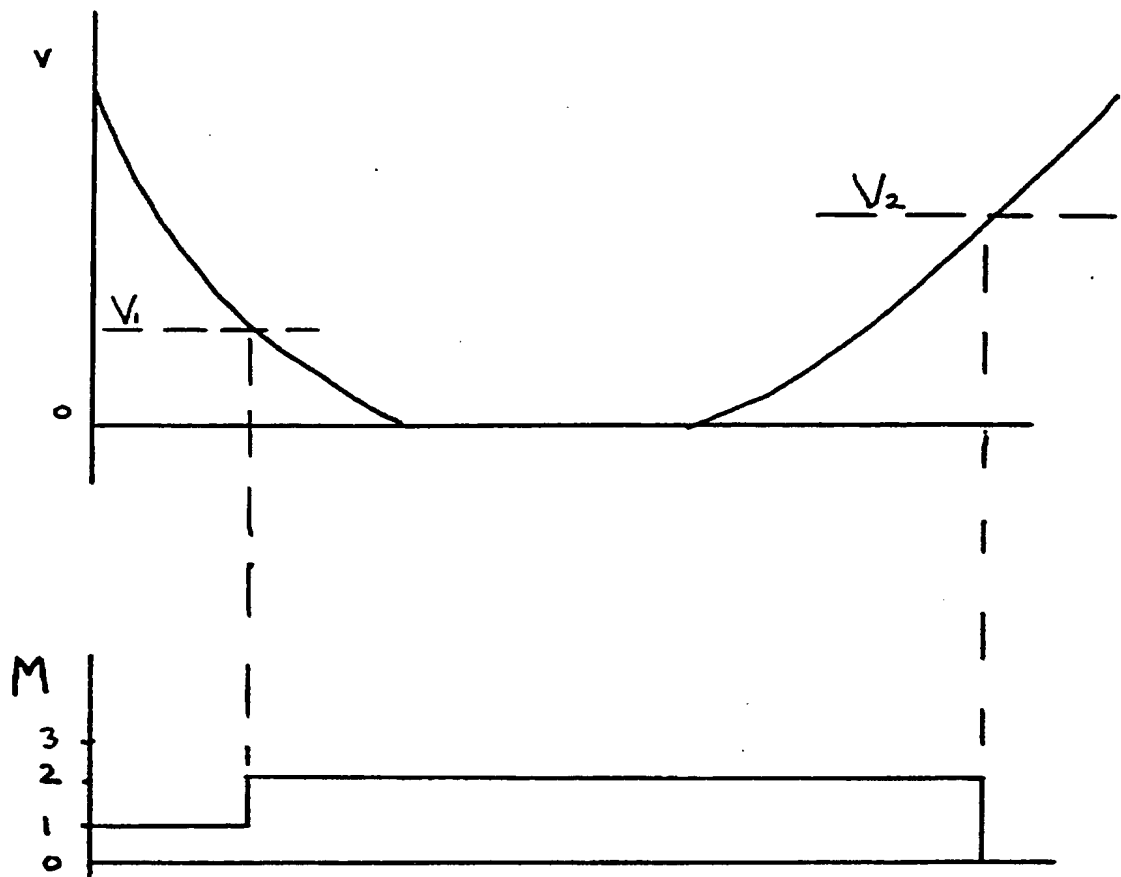


Fig 6



6/9

Fig 7



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Fig 8

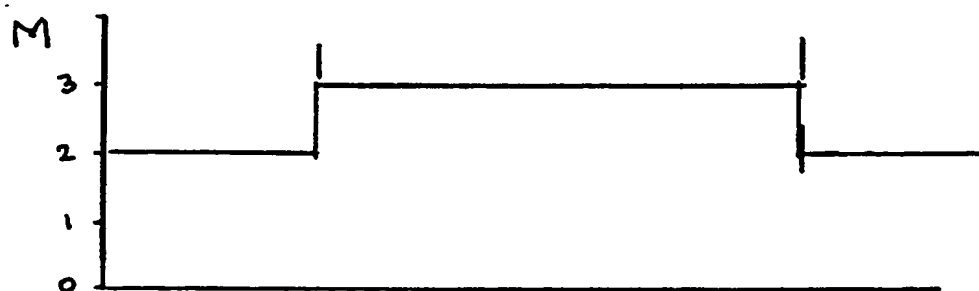
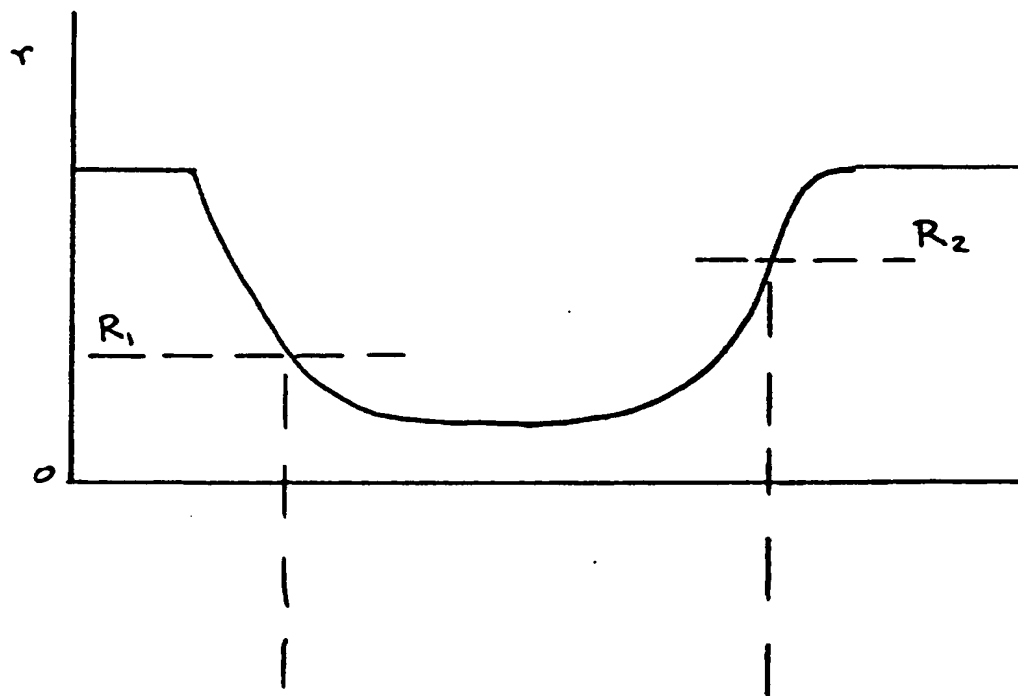


Fig 9

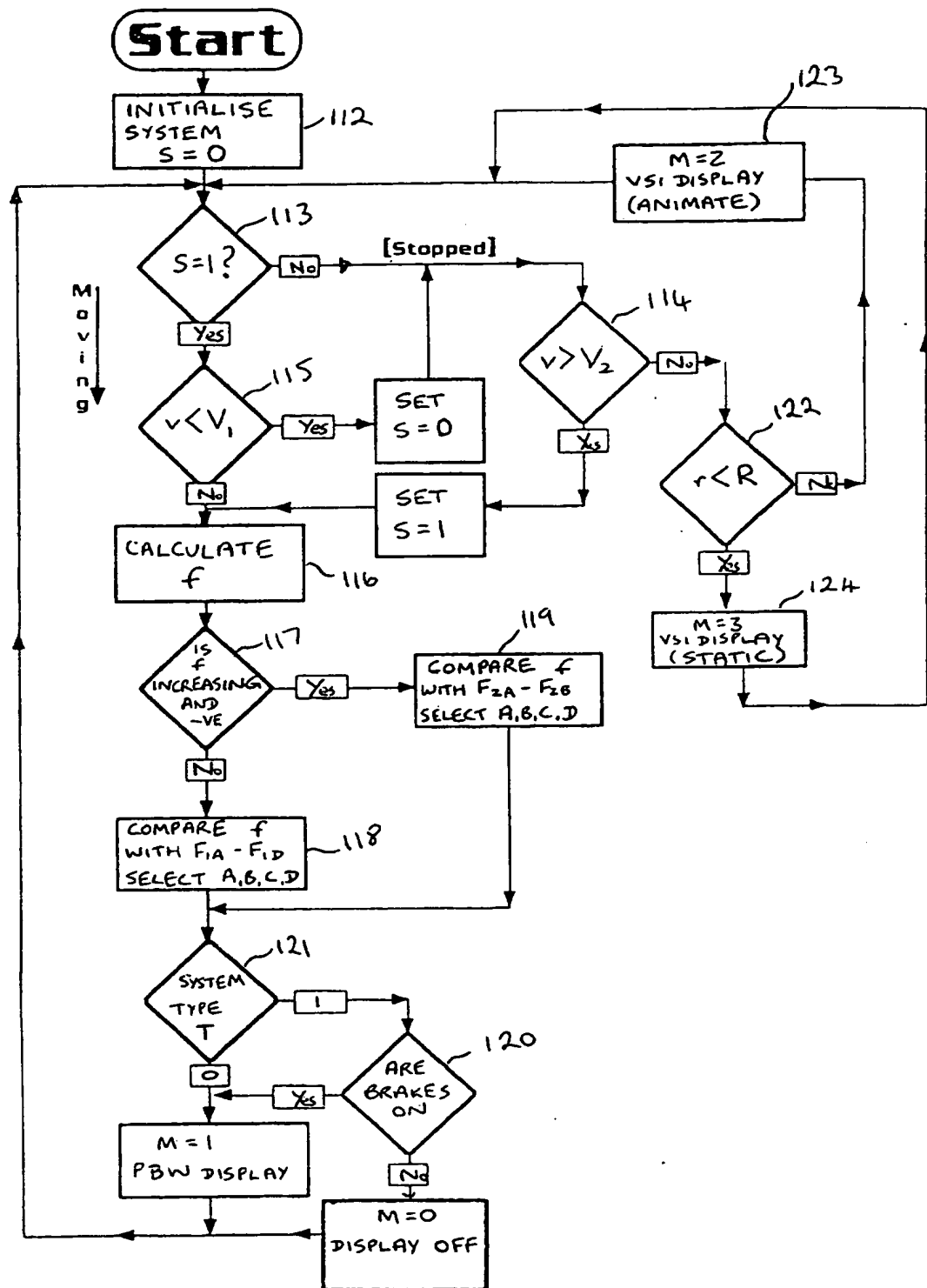
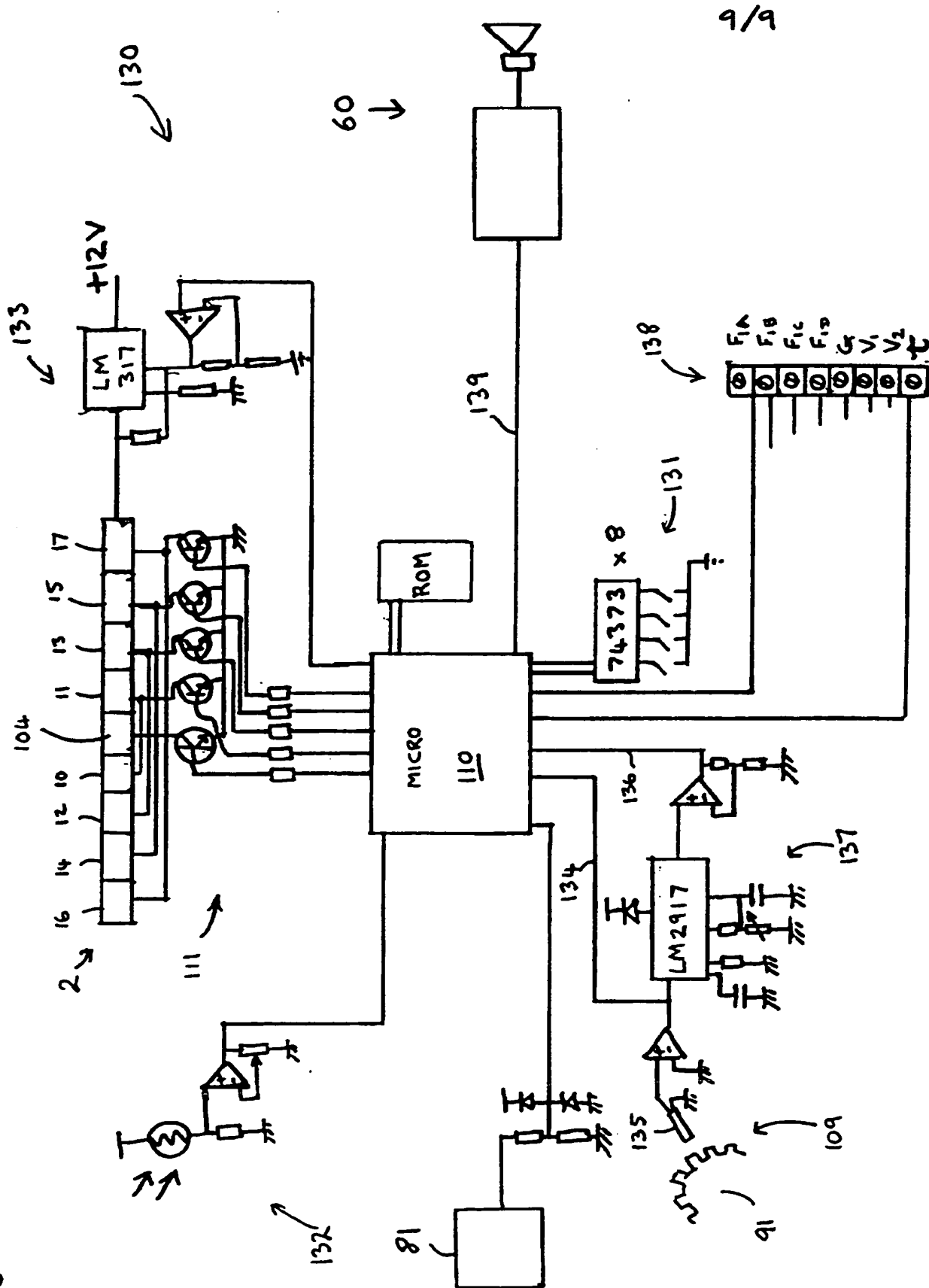


Fig 13



MOTOR VEHICLE DISPLAY SYSTEM AND RANGING DEVICE

This invention relates to a display system for a motor vehicle which enables an observer to gain some appreciation of the magnitude of the deceleration of a subject vehicle from a following vehicle and to be informed whether that subject vehicle is stationary or moving.

Known vehicle display systems include a system which indicates the severity of vehicle braking. One such system is disclosed in Road Research Laboratory Report LR287 issued by the UK Ministry of Transport. Report LR287 discloses a system comprising a multiple brakelight visual display. The number of brake indicator lights which are illuminated in a display is dependent upon the magnitude of deceleration of the vehicle.

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It is also known from WO93/15931 to provide a motor vehicle display system which provides an indication of the vehicle being stationary and adapts the display when proximity of a following vehicle is sensed.

According to the present invention there is disclosed a vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising;

deceleration determining means operable to determine whether the station of motion of the subject vehicle is one of deceleration and to determine a measure of deceleration of the subject vehicle;

vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;

a processor operable to compare the measure of deceleration with a first set of deceleration thresholds defining a first set of distinct ranges of deceleration and to select a level of warning from a corresponding set

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of levels of warning according to the range of deceleration in which the measure of deceleration is determined to lie;

5 indicating means comprising an array of lamps controlled by the processor and operable to provide an indication of the state of motion as being one of deceleration by illuminating selected lamps of the array of lamps to provide a pattern of illumination representative of the selected level of warning such that the number of lamps illuminated is proportionate to the level of warning;

10 and wherein the processor is operable to determine the values of the first set of deceleration thresholds in dependence on the measure of velocity.

The deceleration determining means may be constituted by the processor which may also determine the measure of deceleration from the rate of change of the measure of velocity. Each of the first set of deceleration thresholds may be calculated by the processor to be proportional to the measure of velocity, thereby ensuring that when the vehicle is moving at high speed a relatively small deceleration produces a prominent level of warning and conversely, when the vehicle is moving at slow speed, a relatively high deceleration produces a low level of warning. The system thereby automatically compensates for the vehicle velocity, taking account of the need for fast reaction time at high velocity.

25 A second set of deceleration thresholds may be utilised during periods when the measure of deceleration is decreasing so that the system has an in built tendency to retain an existing level of warning when the measure of deceleration undergoes slight fluctuation. Additionally, or alternatively, the processor may impose a minimum response time before the level of warning is allowed to decrease.

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Preferably the processor discontinues the indication of deceleration when the vehicle velocity is determined to have fallen below a first velocity threshold, the processor then initiating a first indication of the state of motion as being stationary, preferably in the form of an animated display in which lamps are sequentially deactuated to provide a moving pattern of high prominence so as to immediately attract the attention of the driver of the following vehicle.

Preferably the processor is also able to discontinue the first indication of the state of motion as being stationary when the vehicle velocity increases again to above a second velocity threshold which may preferably be greater than the first velocity threshold. This is important during slow traffic situations since it allows the subject vehicle to continue to indicate a warning that it is stationary or slow moving, even when making low speed manoeuvres such as progressively moving forward in a traffic queue.

Preferably the system also includes a proximity sensing means operable to determine when a following vehicle is within a first threshold distance of the subject vehicle, the processor then being operable to modify the first indication of the state of motion being stationary to a less prominent second indication such as a static display consisting of a single pair of lamps continuously illuminated.

According to a further aspect of the present invention there is disclosed a vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising;

vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;

a processor operable to compare the measure of velocity with a first velocity threshold and to determine the state of motion of the

subject vehicle as being stationary when the measure of velocity has decreased to a value less than the first velocity threshold; and

indicating means comprising an array of lamps controlled by the processor and operable to illuminate selected lamps of the array of lamps to provide a pattern of illumination representative of a first indication of the state of motion as being stationary.

According to a further aspect of the present invention there is disclosed a vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising;

vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;

a processor operable to determine the state of motion of the vehicle from the measure of velocity;

indicating means comprising an array of lamps controlled by the processor and operable to illuminate selected lamps of the array of lamps to provide a pattern of illumination representative a first indication of the state of motion as being stationary;

a proximity sensing means operable to determine whether a following vehicle is located within a first threshold distance of the subject vehicle;

and wherein the processor is operable when so determined to modify the first indication of the state of motion being stationary to a second indication of the state of motion being stationary which has less prominence to the driver of the following vehicle relative to the first indication.

Preferred embodiments of the present invention will now be described by way of example and with reference to the accompanying drawings of which:-

FIGURE 1 is a schematic plan view of a subject vehicle and following vehicle in accordance with a first embodiment of the present invention;

5 FIGURE 2 is a schematic circuit diagram of the display system of FIGURE 1;

FIGURE 3 is a schematic representation of a PBW display showing patterns A, B, C and D of a progressive deceleration warning;

10 FIGURE 4 is a schematic diagram showing patterns A to E of an animate VSI display and pattern F of a static VSI display;

FIGURE 5 is a graphical representation of acceleration f and acceleration thresholds F_{1A} to F_{2D} ;

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FIGURE 6 is a graphical representation of the variation in acceleration thresholds with speed;

FIGURE 7 is a graphical representation of an example of speed variation and speed threshold values;

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FIGURE 8 is a graphical representation of measured vehicle range and range thresholds;

25 FIGURE 9 is a flow chart showing microprocessor operation;

FIGURE 10 is a schematic illustration of an alternative configuration of lamps;

30 FIGURE 11 is a schematic illustration of a further alternative configuration of lamps;

FIGURE 12 is a schematic illustration of a further alternative lamp configuration; and

5 FIGURE 13 is a schematic circuit for a further alternative embodiment of the present invention.

Figure 1 shows schematically a subject vehicle 101 to which a display system 1 in accordance with the present invention has been fitted. The display system 1 comprises an array 2 of red lamps mounted on a rear portion 102 of the subject vehicle 101 so as to extend transversely of the subject vehicle in a horizontal row, so as to be clearly visible by the driver of a following vehicle 103.

15 In addition to the normal brake lamps (not shown) of the subject vehicle, the subject vehicle 101 is provided with a red central high mounted stop lamp (CHMSL) 104.

20 A proximity sensor 60 is mounted on the rear portion 102 so as to be rearwardly facing and comprises a microwave device operable to emit a narrow beam of microwaves 105 to detect the presence of the following vehicle 103 and to determine the range r between the following vehicle and the rear portion 102 of the subject vehicle 101.

25 A radio transmitter 106 is also mounted rearwardly facing on the rear portion 102 and is operable to transmit a directional transmission for reception by a radio receiver 107 mounted on the following vehicle 103. The following vehicle 103 is provided with a dashboard mounted indicator 108 which is responsive to signals received via the radio receiver 107 to provide the driver of the following vehicle with a dashboard visual display corresponding to a visual display provided by

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the array 2 of lamps. The dashboard indicator may therefore comprise a miniature array of lamps or any form of display providing an illuminated representation of an array of lamps.

5 As shown in Figure 1, both the subject vehicle 101 and the following vehicle 103 have corresponding equipment so that the subject vehicle is provided with a radio receiver 107', a dashboard mounted indicator 108', and the following vehicle is provided with a radio transmitter 106',
10 an array 2' of lamps, a CHMSL 104' and a proximity sensor 60'. It is envisaged that the above equipment should be standard equipment on all such vehicles in a given traffic situation.

As shown in Figure 2, the display system 1 relies for its operation on a microprocessor 110 which receives an input from a speed sensor 109 of
15 the subject vehicle 101 which determines the speed v of the subject vehicle derived from the rate of rotation of the road wheels. In this embodiment, the subject vehicle's ABS braking system includes a Hall effect sensor, the output of which is processed by circuitry forming part of the speed sensor 109 to provide a signal representative of road speed
20 to the microprocessor 110.

The microprocessor 110 is also connected to the brake pedal switch 81 so as to receive an input B representative of whether the brake pedal is depressed or released.

25 The microprocessor 110 also receives an input from the proximity sensor 60, representative of the range r of the following vehicle.

The microprocessor 110 samples input data at a rate of 1000 cycles per
30 second and is operable to update control of the lamp driving circuit 111

at this same rate, thereby defining the response time of the display system 1 at 0.001 seconds.

5 The microprocessor 110 provides an output to a lamp driving circuit 111 which is operable to selectively supply electrical power to each of the lamps forming the array 2, the microprocessor being operable to effect switching of the lamps via the lamp driving circuit to create visual patterns defining a series of distinct display modes which are referred to below with reference to a display mode parameter M having values 0, 1, 10 2, or 3. Corresponding data defining the display mode is also output from the microprocessor 110 to the radio transmitter 106 to be reconstituted in the radio receiver 107 and displayed on the dash board mounted indicator 108.

15 The CHMSL 104 is actuated independently of the microprocessor 110 and of the lamp driving circuit in response to actuation of the brake pedal switch 81.

The available display system modes will now be described. When the 20 subject vehicle 101 is proceeding at speed and is not decelerating, each of the lamps in the array 2 is extinguished, $M = 0$ thereby defining the OFF state of the display system. In this state the CHMSL 104 may be illuminated by actuation of the brake pedal, the CHMSL being independent of the array 2 and actuated in unison with the conventional 25 brake lights (not shown) of the subject vehicle 101.

In a first display system mode, $M = 1$, the array 2 of lamps is driven in a manner which generates a progressive brake warning (PBW) visual display in which the number of lamps illuminated increases with 30 increasing severity of deceleration. As shown in Figure 3, mild deceleration causes a central pair of lamps 10 and 11 to be illuminated.

If the rate of deceleration is increased, a second pair of lamps 12 and 13 is also illuminated. Further increased deceleration causes a third pair 14 and 15 to be illuminated and finally a maximum indicated deceleration corresponds to the additional illumination of an outer pair 16 and 17.

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First, second, third and fourth level of warning of the state of motion being one of deceleration are therefore indicated by the displays A, B, C and D respectively of Figure 3. The CHMSL 104 is indicated as being illuminated in Figure 3 in each of these displays although this not need necessarily be the case, if for example deceleration were effected other than by actuation of the foot brake.

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The PBW visual display will be readily observed by the driver of the following vehicle 103, the nature of the visual display being such as to immediately convey to the driver of the following vehicle the severity of deceleration of the subject vehicle 101, thereby enabling the driver of the following vehicle to take appropriate braking or evasive action. A corresponding visual display is presented to the driver of the following vehicle by means of the dash board mounted indicator 108.

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A second display system mode, $M=2$ is illustrated in Figure 4 in which patterns of illumination A, B, C, D and E are sequentially and cyclically displayed to provide a vehicle stationary indication (VSI) to indicate to the driver of the following vehicle 103 that the subject vehicle 101 is either stationary or near stationary, in order to alert the driver to a potential hazard. This animated visual display is provided by illuminating the lamps and sequentially deactuating selected pairs of lamps to create a pattern cyclically moving symmetrically outwardly from the central portion of the row to both left and right end portions of the row. The cycle begins at pattern A of Figure 4 where central lamps 10 and 11 are deactuated, then moving to pattern B where the second pair of lamps 12

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and 13 are deactuated, the third pair 14 and 15 being deactuated at pattern C and the outer pair 16 and 17 being deactuated at pattern D. Pattern E of Figure 4 displays all of the lamps simultaneously and is followed by pattern A to repeat the cycle.

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This cycle of patterns gives the appearance of movement from the centre towards left and right extremities and gives the viewer a perception of the lights growing towards the viewer. Such a display has a deliberately high attention grabbing effect.

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A third display system mode, $M = 3$, is illustrated in Figure 4 by pattern F which is continuously maintained to provide a static visual display in which only the outer pair 16 and 17 of the lamps are illuminated. The third display system mode is used to indicate to the driver of the following vehicle that the subject vehicle remains stationary or near stationary, the third display system mode being adopted in situations where the following vehicle is sensed to be in close proximity with the subject vehicle and it is appropriate to discontinue the animated display of the second display system mode in order to reduce the number of lamps illuminated, thereby reducing the likelihood of causing dazzle or annoyance to the driver of the following vehicle. It is therefore apparent that both the second and third display system modes provide VSI visual displays and corresponding visual displays are provided by the dashboard mounted indicator 108.

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The second and third display system modes ($M = 2$, $M = 3$) provide first and second indications respectively of the state of motion of the subject vehicle being stationary, it being understood that the "stationary state" indications are appropriate to the vehicle speed being zero or close to zero.

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The above visual displays are each recognisable unambiguously from one another and have been selected to be immediately recognisable as being different from any existing vehicle display. Both the PBW and VSI displays have been designed to be intuitively and instantly
 5 comprehended by the driver of a following vehicle 103, even if the driver has never before been exposed to such displays.

Operation of the display system in the first system mode $M=1$ is illustrated in Figures 5 and 6. Figure 5 provides an upper graph of
 10 acceleration f against time for the subject vehicle, acceleration f being determined by calculation of the micro-processor 110 based on input values of speed v as measured by the speed sensor 109. The initial portion of the graph shows acceleration f decreasing sharply from positive acceleration to a negative value in response to heavy braking
 15 during which the brake pedal switch 81 is actuated. When the rate of deceleration equals a threshold F_{1A} , the system mode changes from 0 to 1 as illustrated in the lower portion of Figure 5 in the graph of M against time. The array 2 of lamps is actuated such that pattern A of Figure 3 is displayed, pattern A consisting of illumination of lamps 10 and 11. As
 20 the deceleration increases to a further threshold F_{1B} , the display changes to pattern B of Figure 3 in which additionally lamps 12 and 13 are illuminated. Further increasing deceleration to cross thresholds F_{1C} and F_{1D} similarly changes the pattern through C and D of Figure 3.

25 In the example of Figure 5, the rate of deceleration subsequently begins to decrease (i.e. acceleration f increases back towards 0) such that a second set of thresholds F_{2D} through F_{2A} are crossed thereby changing the display to pattern C, B and A and finally to turn off the array of lamps when F_{2A} is crossed, i.e. M is reset to 0. The thresholds F_{2A} to
 30 F_{2D} of the second set correspond to lower levels of deceleration than the respective thresholds of the series F_{1A} to F_{1D} respectively

(i.e. $|F_{2A}| < |F_{1A}|$, etc.) as illustrated in greater detail in Figure 6. Furthermore, each of the threshold values F_{1A} to F_{2D} is dependent on the value of speed v of the subject vehicle. The amplitudes of thresholds are linearly proportional to v as illustrated in the left and right hand portions of Figure 6, the left hand portion illustrating the thresholds F_{1A} to F_{2D} corresponding to $v = 50$ mph and the right hand portion of Figure 6 illustrating the corresponding thresholds at $v = 15$ mph.

The differences between the thresholds F_{2A} to F_{2D} and F_{1A} to F_{1D} are provided to avoid excessive switching between patterns of the PBW display resulting from insignificant fluctuations in the level of deceleration. The dependence of the threshold magnitude upon speed v automatically compensates for the need to provide a more significant level of warning to the driver of the following vehicle during high speed manoeuvres compared with the less significant level of warning required in relatively slowly moving traffic situations.

Figure 7 illustrates graphically the manner in which the VSI display is actuated in dependence upon the value of speed v of the subject vehicle. The upper portion of Figure 7 shows the variation of speed v against time for the subject vehicle decelerating to a halt and subsequently accelerating away. The display system is initially in the first display system first mode, $M = 1$, in which the PBW display is actuated according to the value of deceleration. This is indicated by the lower portion of Figure 7 in which the value of M is indicated graphically. When the value of speed v decreases to cross a first speed threshold V_1 corresponding to the subject vehicle being almost stationary, this is detected by the micro-processor software which changes the system mode to commence the VSI display ($M = 2$) in accordance with the sequence described above with reference to Figure 4, cyclically displaying patterns A to E. The subject vehicle

subsequently becomes truly stationary when speed $v = 0$, $M = 2$ being sustained throughout this period in this example.

5 The subject vehicle subsequently moves off with speed v increasing progressively and passing through a second speed threshold V_2 . This is detected by the micro-processor software which resets the display system mode to "OFF" ($M=0$), the VSI display thereby being discontinued. The VSI display may be actuated irrespective of whether the brake switch 81 is actuated.

10 In the preferred embodiment of the present invention, $V_1 = 2\text{mph}$ and $V_2 = 5\text{mph}$.

15 Figure 8 illustrates graphically the manner in which the VSI display depends upon the measured value of range r between the following vehicle and the subject vehicle. The upper portion of Figure 8 shows an example of how r varies with time in a situation in which the subject vehicle is initially stationary. The following vehicle is initially beyond the range of the proximity device, then approaches from the rear in close proximity, and then the subject vehicle moves off slowly at a speed less
20 than V_2 , as in the case of a traffic queue.

As illustrated in the upper portion of Figure 8, the measured value of range r is initially at a maximum value corresponding to no following
25 vehicle having been sensed. The measured value of range r begins to decrease towards 0 when the following vehicle comes into range of the proximity sensor and progressively decreases until a first range threshold R_1 is crossed. At this point, the system mode parameter M as shown in the lower portion of Figure 8 changes from $M = 2$ (corresponding to the
30 subject vehicle being stationary and the animated display being in progress) to $M = 3$, thereby changing the VSI display to pattern F of

Figure 4 in which the outer pair of lamps 16 and 17 remain continuously illuminated in a static display.

Subsequently the subject vehicle moves off and the measured value of range r increases to a second range threshold R_2 thereby triggering a further change in the value of M from $M=3$ to $M=2$. The animate VSI visual display thereby resumes while the subject vehicle moves slowly forward at a speed of less than V_2 . If alternatively the subject vehicle had accelerated to a speed greater than V_2 at the time of crossing the range threshold R_2 , then the system mode parameter M would change to $M=0$, turning OFF the display. In the preferred embodiment, $R_1=10$ feet and $R_2=20$ feet.

By making R_2 greater than R_1 , the display system is able to tolerate traffic queue situations in which the subject vehicle will repeatedly move forward to a further stopped position and the following vehicle will subsequently follow suit. In such traffic queue situations, it is desirable to avoid reverting unnecessarily to the animate VSI display since repeatedly viewing the animate VSI display at close proximity could cause annoyance to the driver of the following vehicle and is unnecessary.

The value of V_2 is made greater than V_1 for similar reasons, i.e. to allow the VSI display to be sustained during slow movement of the subject vehicle while still allowing V_1 to be relatively low in order to trigger the VSI display only when the subject vehicle is stopping.

Figure 9 illustrates schematically and in simplified form a flow chart of software used in the microprocessor 110 in order to achieve the above described method of operation.

An initialising step 112 sets a vehicle state of motion parameter S to 0, thereby making the assumption that the subject vehicle is stationary when the microprocessor begins to run the process. Decision step 113 tests whether the vehicle's state of motion parameter has value $S=1$ or 0, $S=1$ corresponding to the vehicle being in motion, and the transition from $S=0$ to $S=1$ occurring when the measured speed v exceeds the second speed threshold V_2 at decision step 114. The transition from $S=1$ to $S=0$ occurs when the measured speed v is less than the first speed threshold V_1 at decision step 115.

The value of acceleration f is calculated at step 116 and compared with the previous value of f to determine whether f is increasing, i.e. whether the level of deceleration is decreasing. If decision step 117 determines that f is both negative and decreasing, i.e. increasing deceleration is occurring, the value of f is compared with the first acceleration thresholds F_{1A} to F_{1D} at comparison step 118 to select the

appropriate level A, B, C, D of the PBW visual display. If however f is both increasing and negative, i.e. the level of deceleration is decreasing, f is compared with the second acceleration thresholds F_{2A} to F_{2B} at comparison step 119 and the level of warning corresponding to Figure 3 level A, B, C, D of PBW visual display is set accordingly.

The comparison step 118 represents a subroutine which allows the level A, B, C, D of the PBW visual display to indicate increasing levels of PBW which are limited to one transition level at each 0.001 second cycle of the microprocessor, i.e. at each cycle the permitted transitions are OFF to A, A to B, B to C and C to D. The onset of the PBW visual display will always therefore be progressive.

The comparison step 119 however represents a subroutine which allows any transition between levels of PBW such that for example the visual display can be turned OFF in a single cycle.

- 5 In the above described system, the PBW display can be activated only if the brake switch 81 is actuated, this being determined at decision step 120.

10 This dependence on brake switch operation is a requirement of current legislation in certain territories. Ideally however, the dependence on brake actuation would be removed.

15 A further decision step 121 is provided to test whether a system type parameter $T=1$ or 0 , $T=1$ corresponding to the above described system in which the brake switch 81 has an overriding influence on the PBW visual display. To remove this feature, the software can be adapted by setting $T=0$ so that decision step 120 is bypassed. The value of T is input to the microprocessor via a user accessible key switch to thereby enable the system to be adapted for operation in accordance with local
20 legislature i.e. according to whether local legislature requires the brake switch to have an overriding effect on any indication of deceleration to following drivers.

25 For situations in which the vehicle's state of motion parameter $S=0$, i.e. the vehicle is truly stationary or nearly stationary as defined above with reference to Figure 7 and with reference to speed thresholds V_1 and V_2 , the measured value of range r between the following vehicle and the subject vehicle is compared with range threshold R at decision step 122 (the flow chart is here simplified to omit a subroutine determining the
30 value of R to be either R_1 or R_2 as described above with reference to Figure 8). If as a result of this comparison a following vehicle is

determined to be within the defined proximity range, the VSI animate display is initiated at process step 123 to thereby provide a visual display indicating that the subject vehicle is stationary. If no following vehicle is detected within the proximity threshold defined above, the VSI static display is initiated at process step 124 (the flow chart is further simplified here to omit a subroutine which prevents the animate VSI display changing to the static VSI display until three complete cycles of the animate display have been completed).

Figures 10 to 12 illustrate alternative configurations of lamps for use in accordance with the present invention to provide the VSI and PBW visual displays.

In Figure 10, lamps 10 to 17 form a horizontal linear array 2 corresponding to the array 2 of Figure 3 but in which the CHMSL 104 is vertically displaced relative to the remaining lamps so as to achieve visual prominence. In Figure 11, the configuration is varied to include the CHMSL 104 in co-linear relationship with the remaining lamps 10 to 17. Unlike the configuration of Figure 3 however, there is no longitudinal displacement between the CHMSL 104 and the lamps 11 to 17 so that, when not illuminated, the lamps appear to form a uniform linear array.

Figure 12 shows an alternative configuration in which lamps 10 to 17 are grouped as respective left and right hand vertical columns of lamps with the CHMSL being located intermediate and above the columns. During the PBW visual display, lamps 10 to 17 are progressively illuminated in pairs and in an upward direction to indicate progressively increasing levels of deceleration.

A further alternative embodiment will now be described with reference to Figure 13 using corresponding reference numerals to those of preceding figures where appropriate for corresponding elements.

- 5 Figure 13 shows a display system 130 in which a lamp driving circuit 111 drives an array 2 of lamps 10 to 17 and a central stop lamp i.e. CHMSL 104.

10 The microprocessor 110 actuates the CHMSL 104 whenever the vehicle's service brake is operated, as detected by brake switch 81, thereby providing the familiar braking display in which the CHMSL 104 is illuminated whenever the vehicle brake lights are illuminated. The CHMSL 104 is however additionally capable of being illuminated under the control of software in the microprocessor 110 so as to be included
15 as part of the PBW display providing an indication of the state of motion as being one of deceleration, the animated display providing a first indication of the state of motion as being stationary and the static display providing the second indication of the state of motion being stationary when the following vehicle is in proximity to the subject
20 vehicle. Whether or not the CHMSL 104 is to be included in any one of the above displays is determined by the setting of control switches 131 which allow a number of software options to be indicated to the microprocessor 110. Although in general it will be preferable to include the CHMSL 104 in such displays, compliance with statutory legislation
25 may prohibit such control of the CHMSL 104 in certain territories and it is therefore advantageous to allow the software to be adapted by means of such control switches 131.

30 The display system 130 also includes an ambient light sensing circuit 132 which is operable to determine the average ambient light level over a period of ten minutes, thereby enabling the microprocessor 110 to

regulate the intensity of the lamps 11 to 17, 104 by means of a regulating circuit 103 such that under low light level conditions the intensity of the lamps is reduced. This provides the advantage, particularly during night driving, of preventing the driver of a following vehicle from being dazzled by the brightness of the lamps.

The display system 130 has a speed sensor 109 forming part of the subject vehicle ABS system and providing a digital signal 134 to the microprocessor having a pulse frequency which is proportional to vehicle speed, as detected by means of a Hall effect sensor 135 in proximity with a slotted disk 91 rotatable in unison with a road wheel of the subject vehicle. The display system 130 also has the facility of providing the microprocessor 110 with an analogue signal 136 representative of vehicle speed and derived by means of a digital to analogue converter 137 which takes the output of the Hall effect sensor 135 and converts the digital signal 134 to an analogue signal 136. Operation on the basis of either the digital signal 134 or analogue 136 is selected by setting of one of the control switches 131.

When utilising the digital signal 134, the microprocessor 110 determines the measure of vehicle speed v by counting clock pulses of the microprocessor between each pulse of the digital signal 134. When using a relatively fast microprocessor this will generally be a satisfactory method of operation. If however a relatively slow microprocessor is selected, for example on cost grounds, satisfactory operation may not be possible if the frequency of the digital signal 134 is relatively high, as in the case of large diameter slotted disk 91 having a high density of features sensed by the sensor 135. Under such circumstances, operation using the analogue signal 136 would be preferable and selected by appropriate switching of the control switches 131. These switches may also be used to adapt the operation of the microprocessor

when using different types of disk 91 or when using road wheels of different diameter.

5 The display system 130 also includes a set of trim potentiometers 138, each constituted by 10kOhm variable resistors providing a variable voltage input to the microprocessor 110 and manually set to continuously control the value of operating parameters of the software. Four of the trim potentiometers 138 are used to set values of thresholds F_{1A} , F_{1B} , F_{1C} , and F_{1D} . A further one of the trim potentiometers 138 is used to set a speed gain parameter G which is a constant of proportionality determining the relationship between the above deceleration thresholds with subject vehicle speed v . A further two of the trim potentiometers 138 are used to set speed threshold values V_1 and V_2 .

15 The microprocessor 110 in the display system 130 includes software which, when indicating the level of warning in the PBW display, introduces a delay following the selection of a lower level of warning before turning off the appropriate lamps of the display, the software thereby effectively emulating a low pass filter in the instruction to turn off the lamps. This feature ensures that the warning level of the PBW display persists for a sufficiently long period to be recognised by the driver of the following vehicle. In the flow chart of Figure 9 for example, this step would be inserted immediately following step 119.

25 A final one of the trim potentiometers 138 is used to set a time constant τ which defines the delay in turning off lamps of the PBW display in response to decreasing levels of deceleration.

30 The display system 130 includes a proximity sensor 60 which provides an analogue output 139 to the microprocessor 110 and being indicative

of a measurement of range r between the subject vehicle and following vehicle.

5 In each of the above described embodiments, the number of pairs of lamps making up the display and capable of being separately energised may be more or less than the four pairs shown in the preferred embodiments, with a minimum of two pairs being required.

10 The lamps in the preferred embodiments have been shown as being of the same size. The lamps may alternatively be configured such that at least some of the pairs of lamps differ in size from lamps of other pairs and for example lamps 10, 12, 14 and 16 may be of progressively increasing size.

15 The microprocessor 110 may be a dedicated processor chip or alternatively microprocessor control may be provided as one of several functions performed by a multipurpose microprocessor installed in the vehicle for managing operating or safety systems of the vehicle.

20 As an alternative to sensing vehicle speed using the ABS system, any suitable voltage output which is speed dependent may be sensed from the vehicle electrical system, such as for example the circuitry driving the vehicle's tachometer.

25 Similarly, as an alternative to calculating acceleration f from the measured value of vehicle speed v , a measured value of f may be derived directly by means of an accelerometer having a separate input to the microprocessor.

30 A further alternative is to sense vehicle speed independently of wheel rotation by means of an active speed sensor such as for example a

microwave device determining ground speed by analysing the Doppler shift of reflected radiation. Acceleration may then be determined from the rate of change of measured speed.

- 5 In the preferred embodiment, radio transmitter 106 and receiver 107 are used to provide a dashboard display in the following vehicle 103. These features may be omitted so as to rely solely upon the visual display of the lamps 10 to 17. Alternatively, the dashboard display may be relied upon exclusively i.e. without the provision of the lamps 10 to 17.

10

The proximity sensor 60 may alternatively utilise a sonar beam and detector circuit. The proximity sensor may be provided integrally with a sensor for use during reversing of the subject vehicle and operable to indicate to the driver of the subject vehicle the proximity of objects rearward of the vehicle.

15

- The above described embodiment utilises a second set of acceleration thresholds F_{2A} to F_{2D} in order to avoid excessive fluctuation in PBW visual display. Alternatively, a single set of acceleration thresholds F_{1A} to F_{1D} may be utilised in combination with a response time limiting subroutine which measures the elapsed time during which a particular level A, B, C or D of PBW display persists and inhibits relaxation to a level of display indicating a lower level of deceleration until a predetermined response time has elapsed. In the flow chart of Figure 9,
- 20 the comparison step 112 would therefore be replaced by a suitable response time limiting subroutine.
- 25

- As a further alternative, the use of the second set of acceleration thresholds F_{2A} to F_{2D} may be retained in addition to the response time limiting subroutine to provide a more comprehensive mechanism for controlling fluctuation in the PBW display.
- 30

The circuit arrangement shown schematically in Figure 2 provides for the CHMSL to be energised independently of the lamp driving circuit 111. Alternatively, the CHMSL may be connected to the lamp driving circuit
 5 such that the lamp driving circuit controls actuation of both the lamps 10 to 17 and the CHMSL 104.

The lamps 10 to 17 and the CHMSL 104 may then be housed integrally in the same housing structure and may share a common wiring loom.

10

The CHMSL 104 may in the embodiment of Figure 13 be illuminated during at least a part of the VSI animate (or static) display, independently of the brake switch, in order to further enhance the VSI visual display. In particular, the static display may be provided by
 15 illuminating the CHMSL together with the outer pair of lamps 16, 17.

The microprocessor 110 may be programmed to illuminate the CHMSL whenever deceleration is sensed so that the CHMSL is actuated independently of the vehicle brake lights. This is advantageous for
 20 example in the case of vehicles having retarders which operate independently of the braking system.

The acceleration thresholds F_{1A} to F_{1D} in the embodiments of Figures 1 to 13 have amplitudes $|F_{1A}|$ etc which are proportional to the measured
 25 speed v , for example $|F_{1A}| = A + Gv$ where A is a constant and G is a speed gain parameter. G is typically a positive constant value, adjustable in the embodiment of Figure 13 by means of the trim potentiometer 138. The acceleration thresholds may alternatively be determined to be a non-linear function of v , the speed gain G being a
 30 function of speed v and being tailored to provide optimum compensation for vehicle speed to take account of increased stopping distances and

the pronounced effect of reaction time at high speed. Values of G may for example be stored in a look up table.

5 It may also be desirable for G to have negative values if it is found to be appropriate for the amplitude of deceleration threshold to increase with decreasing speed.

10 The value of the speed threshold V_1 utilised to trigger the transition from the moving to stationary values of the vehicle state of motion parameter S (decision step 115 of Figure 9) may alternatively be enhanced to be greater than the value of speed threshold V_2 (decision step 114). This may be appropriated for example where it is perceived to be important to initiate the VSI visual display as early as possible. Appropriate restructuring of the software would be required.

15 It may alternatively be appropriate for V_1 and V_2 to have the same value and the software adapted correspondingly.

20 The lamps 10 to 17 may include conventional filament lamps of the type currently utilised in vehicle brake lamp systems, such filament lamps generally being simple to individually replace in the event of failure. Alternatively, arrays of light emitting diodes may be utilised in order to take advantage of the fast rise time of such devices (i.e. the time to reach 90% of maximum light output), thereby enhancing the speed of response of the display. This may be important when it is necessary to initiate the PBW visual display at high speed.

30 The embodiment of Figure 13 may alternatively comprise a proximity sensor 60 defining a single range threshold R and having a digital output to the microprocessor 110 which indicates either the presence or absence of a following vehicle in proximity with the subject vehicle.

Such a modified proximity sensor may have an adjustably settable range threshold R.

- 5 Any of the above embodiments may alternatively comprise a proximity sensor 60 in the form of a continuous wave doppler shift radar which provides an output indicative of relative velocity between following vehicle and subject vehicle. Such a sensor would respond to the approach of the following vehicle, thereby providing a progressively increasing output which could be identified as being representative of
- 10 the following vehicle entering into close proximity with the subject vehicle. Since however the sensor would provide no output in a static position in which both vehicles were stationary, it would also be necessary to incorporate a latching facility such that the continued proximity of the following vehicle remained indicated to the
- 15 microprocessor software until such time as relative movement corresponding to separation of the vehicles was subsequently sensed. The unlatching step could also be triggered by the subject vehicle's speed v exceeding the second speed threshold V_2 .
- 20 In the above embodiments, the dashboard mounted indicator 108 may additionally or alternatively comprise an audible warning device.

Claims:

1. A vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising;
- 5 deceleration determining means operable to determine whether the state of motion of the subject vehicle is one of deceleration and to determine a measure of deceleration of the subject vehicle;
- vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;
- 10 a processor operable to compare the measure of deceleration with a first set of deceleration thresholds defining a first set of distinct ranges of deceleration and to select a level of warning from a corresponding set of levels of warning according to the range of deceleration in which the measure of deceleration is determined to lie;
- 15 indicating means comprising an array of lamps controlled by the processor and operable to provide an indication of the state of motion as being one of deceleration by illuminating selected lamps of the array of lamps to provide a pattern of illumination representative of the selected level of warning such that the number of lamps illuminated is
- 20 proportionate to the level of warning;
- and wherein the processor is operable to determine the values of the first set of deceleration thresholds in dependence on the measure of velocity.
- 25 2. A vehicle display system as claimed in any preceding claim wherein the processor determines the first set of deceleration thresholds to be proportional to the measure of velocity.
- 30 3. A vehicle display system as claimed in Claim 1 wherein the processor is operable to determine when the measure of deceleration is decreasing and, when so determined, to replace the step of comparing the step of deceleration with a first set of deceleration thresholds by a

step of comparing the measure of deceleration with a second set of deceleration thresholds defining a second set of distinct ranges of deceleration therebetween and to select the level of warning according to the range of the second set in which the measure of deceleration is determined to lie, wherein each of the second set of deceleration thresholds is smaller in magnitude than the corresponding deceleration threshold of the first set.

4. A vehicle display system as claimed in Claim 3 wherein the processor is operable to respond to a decreasing measure of deceleration crossing each of the second set of deceleration thresholds by selecting a lower level of warning only when an existing level of warning has persisted for at least a predetermined minimum response time.

5. A vehicle display system as claimed in Claim 2 wherein the processor is operable to respond to a decreasing measure of deceleration crossing one of the first set of deceleration thresholds by selecting a lower level of warning only when an existing level of warning has persisted for at least a predetermined minimum response time.

6. A vehicle display system as claimed in any preceding claim wherein the processor is operable to determine whether the measure of velocity has reduced from above a first velocity threshold greater than zero to below the first velocity threshold and to thereafter discontinue the indication of the state of motion as being one of deceleration.

7. A vehicle display system as claimed in Claim 6 wherein the processor is operable in response to the measure of velocity being less than the first velocity threshold to initiate a first indication of the state of motion as being stationary.

8. A vehicle display system as claimed in Claim 7 wherein the processor is operable to discontinue the first indication of the state of motion as being stationary in response to the measure of velocity having increased to above a second velocity threshold.

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9. A vehicle display system as claimed in Claim 8 wherein the second velocity threshold is higher than the first velocity threshold.

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10. A vehicle display system as claimed in Claim 7 comprising proximity sensing means operable to determine whether a following vehicle is located within a first threshold distance of the subject vehicle, the processor being operable when so determined to modify the first indication of the state of motion being stationary to a second indication of the state of motion being stationary which has less prominence to the driver of the following vehicle relative to the first indication.

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11. A vehicle display system as claimed in Claim 10 wherein the indicating means is operable to provide the first indication of the state of motion as being stationary in the form of an animated display by illuminating the lamps and sequentially deactuating selected lamps and wherein the second indication of the state of motion being stationary comprises a static display in which selected lamps are continuously illuminated.

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12. A vehicle display system as claimed in Claim 11 wherein the array of lamps comprises a row of lamps extending transversely of a rear portion of the subject vehicle, the row comprising a central portion and left and right end portions, and wherein the indicating means is operable to produce said animated display by illuminating the lamps and sequentially deactuating selected pairs of lamps to create a pattern cyclically moving symmetrically outwardly from the central portion of the row to both left and right end portions of the row.

13. A vehicle display system as claimed in Claim 12 wherein the animated display comprises a sequence of patterns which includes the simultaneous illumination of all of the lamps.

5

14. A vehicle display system as claimed in Claim 12 wherein the continuous static display is constituted by illumination of only a single pair of lamps.

10

15. A vehicle display system as claimed in Claim 10 wherein the proximity sensing means is operable to determine when the range of the following vehicle increases from a value less than the first threshold distance to a value which is greater than a second threshold distance, and when so determined, the processor is operable to reactivate the first indication of the state of motion being stationary.

15

16. A vehicle display system as claimed in Claim 15 wherein the second threshold distance is greater than the first threshold distance.

20

17. A vehicle display system as claimed in Claim 10 wherein the processor is operable to initiate the second indication of the state of motion being stationary only after the first indication of the state of motion as being stationary has persisted for a minimum predetermined time period.

25

18. A vehicle display system as claimed in any preceding claim wherein the processor is operable cyclically such that at successive cycles of operation the processor is operable to compare the measure of deceleration with the first set of thresholds, and wherein the processor is operable to limit the extent to which the selected level of warning changes between successive cycles to be no more than a single increment between successive levels of warning in order of significance in the set of levels of warning.

30

19. A vehicle display system as claimed in any preceding claim wherein the deceleration determining means is constituted by the processor being operable to determine the measure of deceleration from the rate of change of the measure of velocity.

20. A vehicle display system as claimed in any preceding claim wherein the array of lamps comprises a set of pairs of lamps, each pair of lamps comprising a left hand lamp and a right hand lamp disposed to the left and right hand side of a rear portion of the subject vehicle respectively, and wherein the indicating means is operable to indicate the state of motion as being one of deceleration by illuminating a number of pairs of lamps proportionate to the level of warning.

21. A vehicle display system as claimed in any preceding claim comprising a brake sensor operable to sense whether the vehicle is braking and wherein the processor is responsive to the brake sensor so as to actuate the indication of the state of motion as being one of deceleration only when the vehicle is sensed to be braking.

22. A vehicle display system as claimed in any preceding claim wherein the lamps comprise respective arrays of light emitting diodes.

23. A vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising; vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;

a processor operable to compare the measure of velocity with a first velocity threshold and to determine the state of motion of the subject vehicle as being stationary when the measure of velocity has decreased to a value less than the first velocity threshold; and

indicating means comprising an array of lamps controlled by the processor and operable to illuminate selected lamps of the array of lamps to provide a pattern of illumination representative of a first indication of the state of motion as being stationary.

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24. A vehicle display system as claimed in Claim 23 wherein the processor is operable to discontinue the first indication of the state of motion as being stationary in response to the measure of velocity having increased to above a second velocity threshold.

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25. A vehicle display system as claimed in Claim 24 wherein the second velocity threshold is higher than the first velocity threshold.

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26. A vehicle display system as claimed in any of Claims 23 to 25 comprising proximity sensing means operable to determine whether a following vehicle is located within a first threshold distance of the subject vehicle, the processor being operable when so determined to modify the first indication of the state of motion being stationary to a second indication of the state of motion being stationary which has less prominence to the driver of the following vehicle relative to the first indication.

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27. A vehicle display system as claimed in Claim 26 wherein the indicating means is operable to provide the first indication of the state of motion as being stationary in the form of an animated display by illuminating the lamps and sequentially deactuating selected lamps and wherein the second indication of the state of motion being stationary comprises a static display in which selected lamps are continuously illuminated.

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28. A vehicle display system as claimed in Claim 27 wherein the array of lamps comprises a row of lamps extending transversely of a rear

portion of the subject vehicle, the row comprising a central portion and left and right end portions, and wherein the indicating means is operable to produce said animated display by illuminating the lamps and sequentially deactuating selected pairs of lamps to create a pattern cyclically moving symmetrically outwardly from the central portion of the row to both left and right end portions of the row.

29. A vehicle display system as claimed in Claim 28 wherein the animated display comprises a sequence of patterns which includes the simultaneous illumination of all of the lamps.

30. A vehicle display system as claimed in Claim 28 wherein the continuous static display is constituted by illumination of only a single pair of lamps.

31. A vehicle display system as claimed in Claim 26 wherein the proximity sensing means is operable to determine when the range of the following vehicle increases from a value less than the first threshold distance to a value which is greater than a second threshold distance, and when so determined, the processor is operable to reactivate the first indication of the state of motion being stationary.

32. A vehicle display system as claimed in Claim 31 wherein the second threshold distance is greater than the first threshold distance.

33. A vehicle display system as claimed in Claim 26 wherein the processor is operable to initiate the second indication of the state of motion being stationary only after the first indication of the state of motion as being stationary has persisted for a minimum predetermined time period.

34. A vehicle display system as claimed in any of Claims 23 to 33 wherein the lamps comprise respective arrays of light emitting diodes.

35. A vehicle display system for indicating the state of motion of a subject vehicle to a driver of a following vehicle; the system comprising;
5 vehicle motion measuring means operable to sense a measure of velocity of the subject vehicle;

a processor operable to determine the state of motion of the vehicle from the measure of velocity;

10 indicating means comprising an array of lamps controlled by the processor and operable to illuminate selected lamps of the array of lamps to provide a pattern of illumination representative of a first indication of the state of motion as being stationary;

a proximity sensing means operable to determine whether a following vehicle is located within a first threshold distance of the subject vehicle;

15 and wherein the processor is operable when so determined to modify the first indication of the state of motion being stationary to a second indication of the state of motion being stationary which has less prominence to the driver of the following vehicle relative to the first indication.

36. A vehicle display system as claimed in Claim 35 wherein the indicating means is operable to provide the first indication of the state of motion as being stationary in the form of an animated display by
25 illuminating the lamps and sequentially deactuating selected lamps and wherein the second indication of the state of motion being stationary comprises a static display in which selected lamps are continuously illuminated.

30

37. A vehicle display system as claimed in Claim 36 wherein the array of lamps comprises a row of lamps extending transversely of a rear

portion of the subject vehicle, the row comprising a central portion and left and right end portions, and wherein the indicating means is operable to produce said animated display by illuminating the lamps and sequentially deactuating selected pairs of lamps to create a pattern
5 cyclically moving symmetrically outwardly from the central portion of the row to both left and right end portions of the row.

38. A vehicle display system as claimed in Claim 37 wherein the animated display comprises a sequence of patterns which includes the
10 simultaneous illumination of all of the lamps.

39. A vehicle display system as claimed in Claim 37 wherein the continuous static display is constituted by illumination of only a single pair of lamps.
15

40. A vehicle display system as claimed in Claim 37 wherein the indicating means further comprises a central stop lamp located centrally with respect to the array of lamps, the central stop lamp being connected to a brake sensor operable to actuate the central stop lamp in
20 unison with brake lights of the vehicle when the subject vehicle's brakes are actuated, and wherein the indicating means is further operable to illuminate the central stop lamp independently of the brake sensor such that the continuous static display is constituted by illumination of a pair of lamps of the array in combustion with illumination of the central stop
25 lamp.

41. A vehicle display system as claimed in any of Claims 35 to 40 wherein the proximity sensing means is operable to determine when the range of the following vehicle increases from a value less than the first
30 threshold distance to a value which is greater than a second threshold

distance, and when so determined, the processor is operable to reactivate the first indication of the state of motion being stationary.

5 42. A vehicle display system as claimed in Claim 41 wherein the second threshold distance is greater than the first threshold distance.

10 43. A vehicle display system as claimed in any of Claims 35 to 42 wherein the processor is operable to initiate the second indication of the state of motion being stationary only after the first indication of the state of motion as being stationary has persisted for a minimum predetermined time period.

15 44. A vehicle display system as claimed in any of Claims 35 to 43 wherein the lamps comprise respective arrays of light emitting diodes.

45. A vehicle display system substantially as hereinbefore described with reference to and as shown in any of the accompanying drawings.



Application No: GB 9623226.9
Claims searched: 1-6, 18-22

Examiner: M J Billing
Date of search: 28 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK CI (Ed.O): F4R RFA, RFC, RFE; H2H HQS, HSV1, HSV2, HSV3, HSV4.
Int CI (Ed.6): B60Q 1/44, 1/52, 5/00; G08G 1/09, 1/0962, 1/0965, 1/16.
Other: ONLINE : WPI.

Documents considered to be relevant:

| Category | Identity of document and relevant passage | Relevant to claims |
|----------|----------------------------------------------------------------|--------------------|
| Y | GB2260662A (HORTON) - Figs.2,3; Abstract | 1,21 at least |
| Y | GB2245351A (DONNACHIE) - Figs.1-3; Abstract | 1,20,21 at least |
| Y | GB2229532A (PARPIA) - Fig2.3-7; Abstract | 1,19,20 at least |
| Y | WO93/15931A1 (INTERNATIONAL AUTOMOTIVE DESIGN)- whole document | 1,6,19-22 at least |
| Y | US5148147 (KOBRES) - column 5 line 57 to column 6 line 6 | 1,6,19-22 at least |
| Y | US4293844 (RUHL) - column 4 lines 55-68 | 1,6,19-22 at least |

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Application No: GB 9623226.9
Claims searched: 23 to 44

Examiner: Malcolm Billing
Date of search: 24 July 1997

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Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F4R RFA, RFC, RFE; G1K K2J; G4Q QCE; H2H HQS, HSV1, HSV2, HSV3, HSV4.

Int Cl (Ed.6): B60Q 1/44, 1/48, 1/50, 1/52, 1/54, 5/00; G01P 1/08, 1/10; G01S 13/93; G08G 1/09; 1/0962, 1/0965, 1/16.

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Documents considered to be relevant:

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|----------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| X | GB2298534A | (COPS) - Abstract, Claims 1 and 8 | 23-25 at least |
| X | GB2236172A | (MARTIN) - Abstract | 23 at least |
| X | WO96/02853A2 | (DESIGN TECHNOLOGY) - page 1 lines 7-18, page 12 line 1 to page 13 line 33, page 16 lines 2-7, page 25 lines 2-8 | 23, 26-30, 34-40, 44 at least |
| X | WO93/15931A1 | (INTERNATIONAL AUTOMOTIVE DESIGN) - whole document | 23, 26, 27, 28, 30, 34, 35, 36, 37, 39, 40, 44 at least |
| X | US4841276 | (ABEL) - Abstract | 23 at least |
| X | US4807101 | (V-TRONICS) - Abstract, column 5 lines 16-52, column 7 lines 48-65 | 23 at least |
| X | US4806782 | (BERNAL) - Abstract, column 3 line 4 to column 4 line 65 | 23 at least |

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38

Application No: GB 9623226.9
Claims searched: 23 to 44

Examiner: Malcolm Billing
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